PUGET SOUND nearshore PROJECT

A partnership among local, state and tribal governments in Washington state, the U.S. Army Corps of Engineers and other federal agencies, industries and environmental organizations.

Our mission: Protect and restore the functions and natural processes of Puget Sound nearshore ecosystems in support of the natural resources and beneficial uses of Puget Sound and the Puget Sound basin.

Nearshore Ecosystems Conceptual Model

Purpose

The Puget Sound Nearshore Ecosystem Restoration Project's (PSNERP) Nearshore Science Team developed a conceptual model of natural and human interactions within and between Puget Sound nearshore ecosystems. The Nearshore Science Team uses this conceptual model to guide the scientific elements of PSNERP. This fact sheet provides a brief description of PSNERP's approach to develop its conceptual model and a few examples that describe how it can be applied to nearshore restoration.

Underlying Principles and Approach

The state of science about Puget Sound nearshore ecosystems supports the premise that dynamic natural processes, such as seasonal variability in eelgrass beds or sediment movement by storms, are important to maintain key attributes of the Sound, including clean water, viable salmon populations and healthy estuarine wetlands. The science team's conceptual model emphasizes these ecosystem processes ("how it works"), rather than on the structure ("how it looks") of nearshore ecosystems, and how the interaction between processes and structure influence ecosystem functions ("how we benefit from them").

The Nearshore Science Team considers focus on restoring only nearshore structure without reconstituting the underlying processes that drive the ecosystem to be scientifically unsound for three reasons:

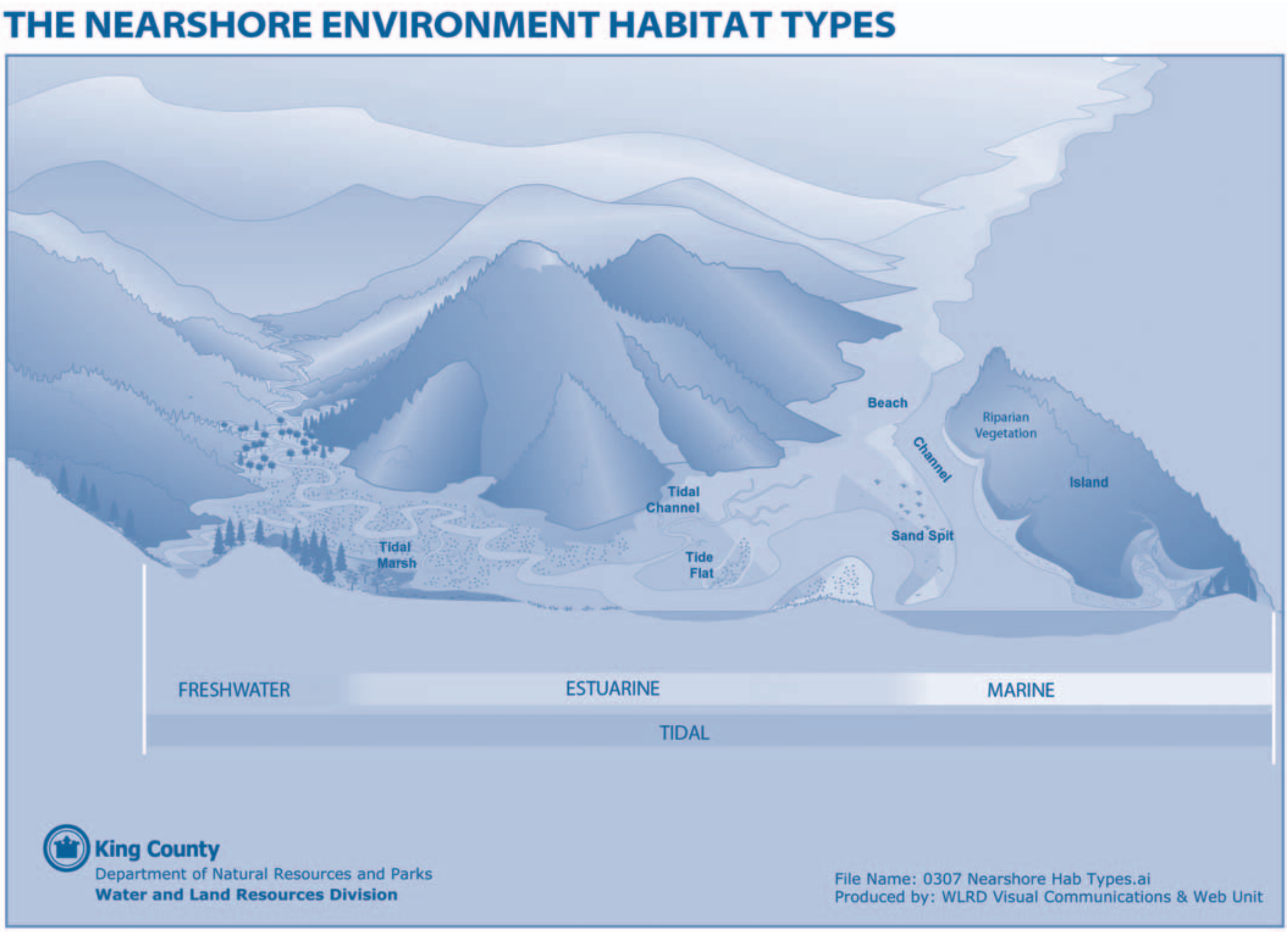
1. The processes are inherently involved in the functions we desire to recover.
2. Without restoring process, the long-term maintenance of the structure and associated functions is highly uncertain.
3. Less likelihood of incorporating or accepting natural ecosystem dynamics and variability in the resulting structure.

Ecosystems are not naturally static in space and time but are continuously being shaped and reshaped by a variety of physical, chemical and biotic processes. This is especially true for environmental interfaces such as the nearshore where water, wind and tides work with local geology, geography and biology to create a highly dynamic system.

Background

Conceptual models are used to define and describe the scope and relationships of a problem. Conceptual models can be very helpful in applied studies of ecological systems, where the objective is to predict the system's response to a particular stressor or remedial action. In environmental science and engineering, conceptual models are used to identify the linkages between information and data, and to generate or test hypotheses about relationships among components or elements of a system. A working conceptual model should, at a minimum, provide insight into the behavior of the system being studied.

An early action of the Nearshore Science Team was to develop and document a process-based understanding of how the Puget Sound nearshore works. This is expressed in terms of how natural nearshore processes shape the structure (what we see) and the dynamics of the Sound's nearshore (how it changes), how alterations by people to these processes affect ecosystem services, and how restoration of degraded processes can improve nearshore function. **A fundamental hypothesis of this conceptual model is that alterations of natural hydrologic, geomorphic and ecological processes alter important nearshore ecosystem structure and function.**



Graphic courtesy of King County Department of Natural Resources and Parks

The Puget Sound nearshore comprises connecting and interacting ecosystems. Conceptual models help to explain our understanding of the relationship between systems, and to more fully consider how actions to restore the nearshore affect ecosystem components.

Use

In addition to guiding the science team's input to PSNERP restoration planning and assessment, the conceptual model should enable:

- Restoration proponents to better conceptualize all the processes and factors that need to be considered to predict the response of a nearshore ecosystem to a restoration action,
- Restoration practitioners to design nearshore protection and restoration actions that restore ecological processes,
- Restoration practitioners to develop process-based monitoring of their projects,
- Scientists to formulate research studies and experiments addressing poorly understood nearshore processes, and
- Restoration program managers and reviewers to better evaluate the logic and underlying assumptions of restoration proposals.

Caveats

It is important to understand what the Nearshore Science Team's conceptual model is and is not.

- It is a starting point toward increased understanding and knowledge, rather than the "final" word on how the nearshore "works."
- It is an evolving tool that will change with more data and understanding.
- It is a descriptive, not quantitative/numeric tool, although it may ultimately be used to develop numerical models to address certain processes.

Photo courtesy of Puget Sound Action Team

The Nearshore Science Team can use conceptual models to predict the response of an action to restore nearshore habitat.

Model Framework

The conceptual model must address a broad range of ecological issues and a diverse regional geography. Therefore, the science team has designed it as a generalized framework for the development of additional, more explicit sub-models to be applied to specific applications, such as nearshore stressors, landscape segments, functions or restoration designs.

The model framework has several important characteristics:

1. It is hierarchical, in the sense that it can be used to describe detailed as well as general ecosystem interactions.
2. It incorporates both spatial and temporal variation.
3. It considers landscape context (landscape relationships and variability).
4. It explains and predicts change.
5. It would be feasible to translate it from a descriptive model into a computational model.

Hierarchical Levels of Complexity

The model is organized in five levels of increasing complexity:

Level 1: *domain;* identifies all interacting links between nearshore ecosystem process and structure, incorporating the influences of stressors on both.

Level 2: *process;* details on all potential processes linking ecosystem elements.

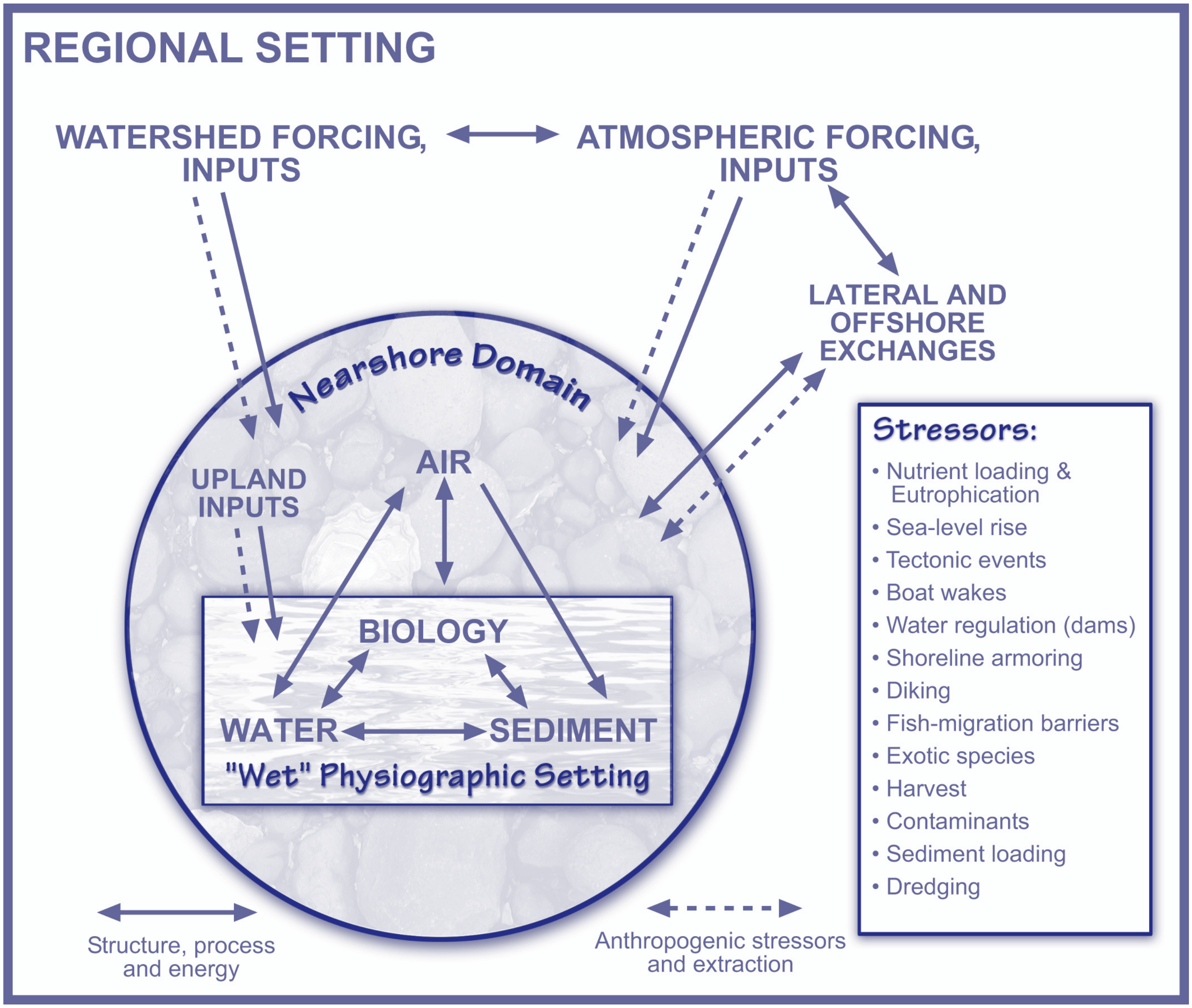
Level 3: *action scenario sub-model;* describes predictable interactions resulting from restoration or other actions directed toward nearshore processes.

Level 4: *spatial scales and landscape context;* spatial scales, variability and landscape context, placing a specific beach or other location of interest along the estuarine continuum between head of tide and open marine waters.

Level 5: *time variability;* different temporal scales (daily, seasonal, interannual); long-term processes; stochastic or catastrophic events.

The schematic on the back page illustrates the domain level (Level 1). It requires identifying the position of the nearshore within the regional setting and the interactions among external and internal forcing factors and ecosystem structure, processes and energy within the nearshore. Forcing factors at the regional scale operate as inputs from the watershed and atmosphere. It is also important to identify exchanges that occur between the nearshore and lateral (adjacent nearshore) and offshore ecosystems. Within the nearshore (circled area), three structural components must be characterized—water, sediment and biology. They occur in the nearshore “wet” physiographic setting (e.g., Extreme High Water (EHW) to deepest limit of photic zone), and are also influenced by both terrestrial and atmospheric factors. In addition, a fourth component—air atmosphere—must be considered because it is also a source and sink of material and energy.

The essence of the Nearshore Science Team's conceptual model is the effect of processes between and within nearshore components (i.e., air, water, sediment and biology) that determines their internal structure. Anthropogenic stressors can originate from both external and nearshore sources, and even within the “wet” portion of the nearshore.



Conceptual Model for the Puget Sound Nearshore Ecosystem Restoration Project Nearshore Science Team Level 1-Domain.

This fact sheet provides a brief introduction to one of the early products of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) Nearshore Science Team.

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